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The Future Soldier System: An Energy Perspective

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By Dr. Robert J. Bunker

Introduction

The Soldier Integrated Protective Ensemble (SIPE) Advanced Technology Demonstration (ATD) has proven to be an ambitious and farsighted project. It is based on a modular subsystem approach which paves the way toward the development of a head-to-toe integrated fighting system for the dismounted infantry soldier. This system is composed of the soldier and everything worn, consumed and carried for use in a tactical environment. Having successfully proven itself, the SIPE ATD will now transition into follow-on programs which will field and demonstrate soldier system prototypes.

The implications of these SIPE follow-on programs on the conduct of war in the 21st century are staggering. *What is in some ways more significant, however, is the fact that these implications ultimately stem from a proposed future increase in non-lethal energy available to the individual foot soldier on the battlefield.* This is a form of energy increase for the foot soldier which has never before taken place and one that will provide the foundation for the follow-on programs which will help alter the face of war as we now know it.

Individual Soldier Energy

Historically, energy has proven to be the underlying factor which determines the level of technology attained by a society. This technologic sophistication, in turn, influences what form of soldier will be fielded and how war will be conducted. To support this statement, we will view the development of individual soldier energy (ISE) over the course of the last 2,500 years of Western civilization. For analytic purposes, we will say that such energy is the energy available to a soldier system for the requirements of mobility and peripheral functions such as communications, climate control and target acquisition.

The energy needs of the soldier system's weaponry will not be factored into this estimate although it can be assumed that as non-lethal energy needs have increased so have the lethal energy needs required for the functioning of more advanced weaponry. The development of individual soldier energy can be divided into three stages which correspond with the classical, medieval and modern epochs of Western civilization. These are shown in Table 1.

Classical Soldier Energy

Individual soldier energy during the classical epoch was primarily based on human muscle. The Greek hoplite and the Roman legionnaire both relied upon their own power for mobility and the use of such weapons as the pike, javelin and short sword. No form of peripheral functions existed because of the primitive level of technology which characterized this era. In estimating ISE, we can say that a classical foot soldier generated about 0.1 horsepower (hp). This was equivalent to the energy basis of classical society since the prime motive source for the economy was founded on slave energy which also produced 0.1 hp.

Classical cavalry, even though it existed in only limited numbers, should also be taken in consideration because of the great influence it could have on the battlefield. Alexander's Companion cavalry was a devastating force as was Hannibal's Carthaginian

Table 1.0 Individual Soldier Energy (ISE)

	Classical Epoch	Medieval Epoch	Modern Epoch
Individual Soldier Energy (Foot)	Hoplite/Legionnaire 0.1 hp	Non-Existent	Rifleman 0.1 hp
Individual Soldier Energy (Mounted)	Cataphract 0.66 hp	Knight 0.66 to 1.0 hp	Tank Crewmen 10.0 hp to 375.0 hp

cavalry whose performance at Cannae is legendary. Horses in the ancient world were smaller and weaker than the larger medieval breeds. For this reason, a mounted classical cataphract generated about 0.66 hp.

Medieval Soldier Energy

The medieval epoch witnessed individual soldier energy shifting away from the foot soldier and fully over to the mounted soldier. This change in focus was a result of animal energy dominating feudal society. The diffusion of the stirrup to Europe allowed the cavalry a secure platform for shock combat. Wearing heavy armor and wielding a lance and a longsword, this cavalryman developed into the feudal knight who dominated the battlefields of Europe.

The knight rode war horses which, in some cases, had been selectively bred over generations. The amount of energy generated by these war horses therefore differed and thus the energy available to this soldier was at times greater than that available to the mounted classical soldier. Normally, the speedy and agile courser, a common breed like that used in the classical world, can be estimated at 0.66 hp. The stronger breeds, such as the Belgian whose immense size and weight made it the perfect charger would, on the other hand, be able to generate 1.0 hp. Even with this increase in individual soldier energy, no peripheral functions existed during this epoch for the soldier system beyond mobility due to the low level of technology. The energy generated was equivalent to the energy utilized by the mature medieval economy which was organized around manoralism. The prime motive source of that economy was initially the ox which only generated about 0.5 hp. Later, the horse was used, generating from 0.66 to 1.0 hp as it became plentiful enough for pursuits other than waging war.

During a long span of the medieval epoch, the infantry—for all practical purposes—did not exist on the battlefield. These troops were no longer even considered soldiers, a distinction belonging now solely to knights. This was made possible because the castle had replaced the infantryman as the rallying point for cavalry and provided a refuge which was invulnerable to conventional attack.

Modern Soldier Energy

The foundations of individual soldier energy have been greatly altered during the modern epoch although this has only taken place during the last century of our era. This is because the modern world has witnessed the rise of two distinct periods of mechanical energy dominance. The initial period was based on wind and water machines which generated somewhere between 5.0 and 15.0 hp. During that period of Western civilization, great advances were made in the lethality of the soldier system although no progress was made in ISE.

The age of mercenaries and the age of limited warfare which existed in the wind and water machine period witnessed the reassertion of infantry on the battlefield and the organization of the economy around mercantilism. This was initially made possible because many attributes of classical warfare such as pike formations were resurrected. These events were ultimately overshadowed by advances in gunpowder based small arms and siege artillery. Siege artillery blasted the knight from his no longer impregnable castle. Small arms such as the arquebus, later musket, cleared the knight from the battlefield and eventually promoted the rise of linear formations of foot soldiers for its proper fielding.

The later energy period was founded on steam and then internal combustion engines and the economy was based on capitalism. These engines generated a low of about 75.0 hp for a Newcomen engine on upward to beyond 500.0 hp for a steam turbine and into the thousands of horsepower for gas turbines. Advanced, large scale turbines, in turn, generated tens and hundreds of thousands of horsepower. Late 18th and 19th century warfare issued in by Napoleonic France saw the rise of weapon lethality based on field artillery and, later, on rifles and early forms of machine guns. Railroads represented an early form of engine based troop transport providing the soldier with strategic mobility, a significant event in itself, but it was not until the First World War that a significant increase in individual soldier energy became apparent.

This increase stemmed from the development of the armored fighting vehicle of which the premier battlefield system is the tank. The tank represents a weapon system which ultimately provided enhanced mobility and full peripheral capabilities such as target imaging and ranging, air filtration and communications. Early tanks such as the French St. Chamond and British Mark IV generated between 90.0 and 105.0 hp respectively. A World War II Sherman generated 450.0 hp, a more modern M60 750.0 hp and a state-of-the-art M1 1500.0 hp. These horsepower ratings while impressive must be adjusted by dividing the horsepower generated by the size of the tank crew for determining individual soldier energy estimates. This has been done in Table 2 and yields ISE figures ranging from 10.0 hp to 375.0 hp

What is glaringly absent during the modern era is an increase in individual soldier energy for foot soldiers. These troops, while armed with semi-automatic and automatic weapons, when dismounted differ little from the classical soldier in terms of their mobility and peripheral capacity because they still only generate 0.1 hp on the battlefield. Only a select few individuals carry communication gear while climate control and target acquisition options for the foot soldier are basically non-existent. The reason for this is because internal combustion engines and turbines, our modern principle generators of energy, are too large to benefit individual foot soldiers.

Future Soldier Energy

For the future soldier system to become a reality, advanced forms of energy generation are required. A solution to this dilemma is now on the horizon because the basis of individual soldier energy is once again

Table 2.0 Modern Individual Soldier Energy (Mounted)

Tank	hp	Crew Size	ISE
St. Chamond	90	9	10
Mark IV	105	8	13
Sherman	450	5	90
M60	750	4	187.5
M1	1500	4	375

Table 3.0 Parametric Model Scenarios

Scenario	Year	Average Power	Peak Power	Total Power
1	1994	0.074 hp (55 Watts)	0.168 hp (125 Watts)	1.777 hp (1325 Watts)
2	1998	0.322 hp (240 Watts)	0.503 hp (375 Watts)	3.218 hp (2400 Watts)

1 Watt = .001341 Horsepower (hp)

radically changing. Seven candidate power sources based on either high technology batteries, engines, radioisotope, or fuel cells were outlined in "A Parametric Model for Soldier Individual Power" by Dugas, Nawrocki, and Raskovich, published in the July-August 1993 issue of *Army RD&A Bulletin*.

This article also outlined two mission scenarios which portrayed soldier system power requirements. These parametric model scenarios, as shown in Table 3, portray part of the first step toward an increase in energy available to the individual foot soldier. While the projected 0.074 hp average mission power requirement in the 1994 scenario and the projected 0.322 hp average mission power requirement in the 1998 scenario appear trivial compared to an M1 tank crewmen ISE figure of 375.0 hp, they are not. The 1994 scenario represents a 74 percent increase in ISE output for the modern foot soldier while the 1998 scenario represents a 322 percent ISE increase.

Another factor to consider is that initial tank ISE increases were minimal compared to later developments because it takes time to work out new technology. These parametric model scenarios, while portraying early soldier system energy requirements based on advanced power source potentials in their infancy, already represent immense future thresholds of energy availabile to the foot soldier.

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Summary

We have witnessed that historically, during the classical, medieval, and modern epochs, the energy available to society determines what form of soldier will be fielded on the battlefield. In the past, this process has benefited both the mounted and the foot soldier in the area of weapon lethality. In the region of non-lethal energy availability, which is the major focus of this article, this process has only benefited the mounted soldier whose ISE generation has increased from 0.66 hp to 375.0 hp while the foot soldier's ISE output has remained since the dawn of classical civilization at 0.1 hp.

With the advent of the future soldier system, we are at the threshold of a new era; an era which will see for the first time in history a non-lethal energy increase for the foot soldier since initial model projections call for an increase in foot soldier ISE by 0.074 hp in the 1994 scenario and by 0.322 hp in the 1998 scenario. It is no coincidence that this event will be taking place soon. The increasing amount of references made by military and academic scholars to post-modern warfare and urban terrorist warfare point toward a shift in not only the foundations of individual soldier energy but also, in turn, in the energy foundations of Western civilization.

This is a shift whose significance cannot be overlooked because it provides the energy basis for SIPE follow-on programs. These programs will contribute to the transformation of war in the 21st century and will set the stage for an eventual increase in individual soldier lethality based on beam weaponry.

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